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ABSTRACT

Through an adaptation of a language experience approach, microcomputer programs were designed to develop the literacy skills of four 4-year-old nursery school children. In order to document the design process, the intervention procedures, and their effects, case studies were made. Instruction was based on a highly interactive strategy with short, frequent cycles of program modification in a variation-selection-retention paradigm. The aim of the intervention study was to progressively select instruction that appeared to be related to the sufficient conditions of children's improved performance. Subjects were seen individually twice per week in 20- to 30-minute sessions at the West Virginia University Nursery School. The experimenters worked with three children each semester: one child in the first semester only, one in the second semester only, and two in both semesters. Programs focused on (1) spelling single words, and (2) composing pictures with letter and word commands, and adding verbal text to the pictures. Results are presented in terms of changes in the children's performance, in the computer programs, and in instructional procedures. Pre- and post-test comparisons indicated that all children improved their literacy skills. Improvements ranged from increased spelling skills to the substantial acquisition of a small writing and reading language system. Discussion of outcomes focuses on reasons for attributing at least partial efficacy to the instructional conditions as a whole and ways the programs could be used in classrooms. (RH)

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Developing Microcomputer Programs for Early Literacy

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Abstract

In an adaptation of a language experience approach, microcomputer programs were designed to develop the literacy skills of four four-year-olds in nursery school. The results are presented in terms of changes in the children's performance, changes in the computer programs, and changes in the instructional procedures. All children improved their literacy skills. These improvements ranged from increased spelling skills to the substantial acquisition of a small writing and reading language system.

Developing Microcomputer Programs for Early Literacy

Computer-assisted instruction (CAI) for teaching reading dates back to the 1960s when stationary mainframe computers were connected to school-based terminals by long distance telephone (Inabinette & Carter-Wells, 1984; Zaharias, 1983). These pioneering efforts were expensive, and it was difficult to demonstrate benefits in learning that justified the costs. There were also problems with the reliability of this centralized system. When a breakdown occurred, it had widespread effects. Since then, the development of the microcomputer has considerably reduced cost and reliability problems. Software limitations were another early problem. Many programs focused on traditional drill and practice methods rather than fully exploiting the computer's capabilities. They were electronic workbooks in place of paper and pencil workbooks (Newman, 1984; Vargas, 1986; Zaharias, 1983). Although much current software continues to allow only a periodic token response from the pupil, much like a multiple-choice item, there are more programs today which make fuller use of the computer's capabilities.

One of the most promising directions for literacy acquisition has been in the development of word processing programs for young children. One reason is that the keyboard helps to overcome any lack of manual dexterity which makes handwriting difficult and messy. In addition, young children's struggle for neatness and a perfect copy, which can occupy so much of their efforts, is considerably aided by the computer

(Loheyde, 1984). Children can easily correct any inadvertant errors which they find bothersome, and the printout looks clean and neat. Another reason for the early acceptance of word processing with young children may be that it lends itself nicely to a language experience approach (Grabe & Grabe, 1985; Smith, 1985). Interestingly enough, a form of word processing for young children, O.K. Moore's Talking Typewriter, was one of the earliest uses of the computer in education (Pines, 1963). This machine would say the letter or punctuation mark of whatever key the child pressed. A more recent use of speech synthesis with word processing is illustrated by The Talking Screen Textwriting Program, which was developed for use with a learning disabled population (Rosegrant, 1984, 1985; Trachtman, 1984).

In addition to speech synthesis, the graphic capabilities of the computer have also been used with young children. Some word processing programs for young children encourage them to create pictures before writing about them (Rodrigues, 1985). Unfortunately, not all of the commercial programs are designed to produce printouts of the child's graphics and text. Like typing with disappearing ink, the absence of a hardcopy defeats one of the major advantages of writing, its enduring availability for examination. In addition, printouts are important for motivation and for a detailed record of children's progress.

Word processing programs for young children, then, have been distinguished by their use of speech synthesis, graphics

production, hard copy printouts, and adaptation to language experience approaches, although it is still rare to find all these features in one program. In addition, some of the more systematic uses of word processing programs are often accompanied by special programs (Martin, 1986) or activities (Rosegrant, 1985) for developing spelling skills. One important feature missing from most commercial software, however, is ease of modifiability by the teacher (Blohm, 1985). This restricts the ease with which a teacher may make improvements and individualize the programs to student needs.

At a theoretical level, the use of word processing programs supports an early incorporation of writing and reading, using writing as an introduction to reading in what might be called a compositional approach to reading (Moxley, 1984). Children who can write meaningful sentences in a complete if small language system have an introduction to the essential organizational features of their language. They can then use this knowledge of the "system" when they read sentences with words they cannot spell. In this way, a small writing vocabulary can be a meaningful introduction to a far larger reading vocabulary. As Clay (1975) put it, "The function of early writing experience would be to develop the visual attending or orienting behaviours needed for attending to the detail of written language. If these are learned in one or two particular situations (a few words and a few simple sentence patterns) they may then be applied to a whole class of similar situations in later reading" (p. 74).

Taking advantage of the computer's inherent capability for speech synthesis, graphic displays, hardcopy printouts, adaptation to language experience approaches, and ease of modification, the following study applies these capabilities to developing early writing and reading skills. A brief account of the children's early progress in the first semester, emphasizing spelling skills, was reported earlier (Moxley & Barry, 1985). To provide a comprehensive overview, we have included the children's performance from the first semester with their performance in the second semester when there was more emphasis on the writing and reading of their compositions.

Before presenting the body of our study, a few comments about its methodological orientation may be in order. In the conduct of this study, we have pursued the iterative, interventionist tactics for developing programed instruction (see Green, 1967). We have also sought to enhance the evolutionary development of these programs by taking advantage of 1) the computer's capability for supplying frequent, detailed records of student responses and 2) the easy modifiability of the computer programs. This has meant pursuing a highly interactive strategy with short, frequent cycles of modification in a variation-selection-retention paradigm (Campbell, 1966). This sets the evolutionary or developmental clock of the programs ticking faster. Hopefully, the data supplied here will be sufficient for determining whether features of these or similar programs deserve to survive for further development.

In general, our overall strategy includes features of experimentation, data guidance, program evaluation, and the qualitative methods and personal knowing decribed by Tharp (1981). More particularly, this includes exploratory probes (Sidman, 1960; Sidman & Stoddard, 1966), an informal way of component building (Slavin, 1984); case study descriptions adapted to participant observation in an interventionist context; a formative evaluation in developing these programs rather than a summative evaluation of the programs as final products in comparison with other products (Bloom, Hastings, & Madaus, 1971; Moxley, 1974); and the abductive generation of hypotheses, which is so useful in an initial, exploratory investigation (see Guthrie & Hall, 1984; Hoffman, 1986; Overholt & Stallings, 1976).

Although summative methods of evaluation are not incompatible with the validation of programed instruction as finished products, they are not essential for program validation (see Markle, 1967), and we do not regard the programs presented here as finished products. It is more appropriate to regard published paper-and-pencil materials and commercial software as finished products since they are not easily or frequently revised. In contrast, there is nothing inherent in computer programs which limits their subsequent modification unless the manufacturer prohibits it with, say, copy protection. With a programing language like Logo, which is easy to learn gradually, teacher modification of computer programs can be a continuing, on-going process.

Thus, the purpose of this study is not to determine necessary causal connections between the components of instruction and student performance. Rather, the purpose is to progressively select instruction that participates in the sufficient conditions for improved performance. Components of instruction that are followed by improvements are kept, those that are not followed by improvements are dropped. Each cycle of instructional design and tryout offers an opportunity to consider new canditates for elimination or inclusion. On this basis, the instruction that survives is "formed" until a point is reached where summative methods of comparison and evaluation are deemed appropriate. In this regard, the programs that follow are still in an exploratory, formative stage. They show an evolving degree of feasibility and compatiblity with improved student performance. Precisely what is necessary for that improvement remains to be seen.

The Wordpicture Programs

We worked with four four-year-olds individually at the West Virginia University Nursery School. We worked with three children each semester, one child in the first semester only, one in the second semester only, and two in both semesters. Two children were worked with at counter-balanced, different semesters so that we could include both a baseline and a followup period without our instructional treatment. Thus, during the entire period of instructional treatment, there was a child who was tested while off that treatment. The equipment consisted of an Apple II+ microcomputer with an RGB monitor,

which allowed for a sharp text as well as color; an Apple Dot Matrix Printer for copies of the children's graphics, texts, and spelling records; a Grappler interface card for the printer; and an Echo General Purpose Speech Synthesis Unit. The programing was done with Terrapin Logo 2.0.

We worked with the children twice a week in 20 to 30 minute sessions. In addition to the ongoing assessment from their daily records, we pre- and posttested the children with letter cards, word cards, and sentences based on words from our programs and a few function words (AND, BOY, CAT, DOG, GIRL, HOUSE, RUN, SEE, THE, TO, TREE, and WALK).

Two types of programs focused on spelling single words. The LETTER-SEQUENCE programs presented a picture that represented the word, and the word was shown with a missing letter. It began with the first letter missing (e.g. __OG). If the child pressed an incorrect letter or the RETURN key (for help), the correct letter was shown briefly. It would then vanish along with any incorrect letter, and the child had another opportunity to type in the correct letter. The name of each letter was pronounced by speech synthesis as it was typed. When the correct missing letter was pressed, it remained on the screen, and the word was presented with the next letter missing (e.g. D__G). This continued until the child had typed in all the correct letters. At this time the word would be pronounced by the speech synthesis unit and the display for the next word would be presented.

The early SPELL programs presented a picture that represented the word, and then the word was shown about four seconds before vanishing. The child could have the word reshown at any time by pressing the RETURN key for help. When the child completed the spelling of the word with each letter name pronounced by speech synthesis as it was typed, the correct spelling was shown above the child's. If the child's response was incorrect, the correct spelling vanished along with the child's spelling, and the child had another opportunity to type in the entire word. If the child's spelling was correct, it was "highlighted" in comparison to the correct spelling shown above the child's, the word was pronounced by the speech synthesis unit, and a new picture and word were presented. The later SPELL programs did not present a picture. Instead, the word was pronounced by the speech synthesis unit and immediate feedback was given as the child typed in each letter. The correct spelling of the word was shown as soon as the child typed an incorrect letter and correct letters remained on the screen. See Table 1 for examples of the letter displays in the Spell programs.

Insert Table 1 about here.

When the child had finished with either the LETTER-SEQUENCE or the SPELL programs, a record of the child's performance was printed out. In addition to showing each word that the child ultimately spelled correctly, this record showed each invented

spelling as well as each request for help. See Figure 1 for an example of a spelling record.

Insert Figure 1 about here.

Two types of programs focused on composing. In the FASPICTURES programs, the child could move the cursor anywhere on the screen for placing a picture. In FASPICTURES-LETTERS, if the child moved the cursor to the top of the screen and pressed the key for S, a picture of the sun would be drawn there. In FASPICTURES-WORDS, the child needed to type in the entire word for the picture before it would appear. When they were finished composing their pictures, the children dictated "stories" for them. The stories were typed on the computer and included in the printouts of the pictures. These then became the texts for the children to read back aloud. The child also had the option of having the speech synthesis unit read back from the text one word at a time for each press of the space bar, each word highlighted as it was spoken. When the children read any of their compositions back from the printout, we led them through it from the beginning, pointing to each word. If they needed help, we would say the word for them, and move on to the next word. Eventually the pointing became unnecessary. See Figure 2 for an example of a printout of a FASPICTURES program.

Insert Figure 2 about here.

In the FASPICTUREWRITING programs, schematic figures for verbs were included and the cursor was automatically positioned in a left to right and top to bottom sequence for each word-for-a-picture typed in. Any sequence of words typed by the child would remain on the screen, but only the content words in the program vocabulary would result in a picture. The speech synthesis option was the same as for the FASPICTURES programs. See Figure 3.

Insert Figure 3 about here.

In using the composition programs for their own writing during the first semester, the children were encouraged to write as much as they could on their own and to invent spellings. When there was a writing "block", help was given. This help ranged from an open-ended question, e.g. "What did the bird do?", to putting the word on a card in front of the child to copy. We prompted them to rehearse the spelling of the word out loud before looking away to type it in. If further help was wanted, they could place the word card in front of them to copy. During the second semester, word cards were not placed in front of the child for copying. Instead, when help was needed, they were shown briefly to the child in the teacher's hand. Overt rehearsal and recall was then encouraged. The last procedure we used here with the children was to have them first make up a sentence from the spelling words that day or from their story. They would then dictate that sentence, or any other sentence of

their choice, and we wrote it down. In turn we would read their sentence back to them, and they would write it as we dictated. As with all the programs, printouts of the children's work were made when the children were finished. One copy was given to the child to take home, and another was collected in individual booklets.

Results

The children's pre- and posttest scores are shown in Tables 2 to 5. The most striking improvements show up in items 9 (types to dictation) and 10 (free writing). Each child's progress in composition, in dictation and their own writing, is shown for each semester in Tables 6 to 11. If not already able to do so, each child learned to identify all the letters of the alphabet by name, to arrange words for compositions in more complexity than a listing, and to read them back aloud when asked. In general, the dictations show a steady progress from a simple listing of items to a thematically centered narrative. Progress in writing proceeds in the same direction but falls short of the compositional sophistication of their dictations. Karen's progress in reading her dictations aloud, a focus of the second semester (which was Karen's first semester working with the programs), is shown in Table 12. Judy's progress is shown in Table 13. We show no table on reading for Mark since he always read correctly whatever he dictated. In general, Tables 12 and 13 show a steady improvement in the children's ability to read back their dictations accurately. The setback that shows up in the middle of Judy's progress (Table 12) occurs when she

begins to work on programs with a new vocabulary, but that difficulty is soon overcome. Figures 4 to 7 show each child's progress in spelling. These records include the percent correct for words in isolation spelled without help or errors and for letters spelled correctly in self-constructed sentences. Discounting the difficulties that appear when the children were presented with a new spelling program, these records show a steady progress, if less pronounced than that shown in the tables for composition and reading, in the children's development of spelling skills for both words in isolation and in context.

Insert Tables 2 to 13 and Figures 4 to 7 about here.

Most of the trends were upward. Some were sustained upward fairly strongly over a period of time, e.g. in reading aloud (Judy and Karen in the second semester) and in SPELL.I (Mark and Karen in the second semester). The downward trends in a particular program for a particular semester were in spelling and were brief. One reason they were brief is that the children were usually switched to another program when they had increasing difficulties. Some downward trends occurred when a child had a high level of initial difficulty with a program, getting only one or two items correct without help (Mark 11/26, 11/28 in SPELL.I; Judy, 10/4, 10/10 in LETTER-SEQUENCE.I; Karen 3/20, 3/27 in LETTER-SEQUENCE.II). Other downward trends occurred when a child had increasing difficulty with an entirely

new set of vocabulary words (Kevin 12/3, 12/5 in SPELL.II and Karen 3/20, 3/27 in LETTER-SEQUENCE.II). One downward trend occurred when new words were introduced into a program (Karen 4/15, 4/17, 4/29 in LETTER-SEQUENCE.I). Another downward trend occurred in a program that was subsequently discontinued (Judy 10/20, 10/29, 11/26 in SYLLABLE-SEQUENCE.I). The following describes the overall changes in each child's performance as well as changes in the programs and procedures in more detail.

Changes in the Children's Performance

Over time the children adopted different strategies to handle the complexity of the spelling tasks they faced. They copied, sounded out, rehearsed the spellings out loud, paused in their rehearsal between clusters of letters, and used visual recall. In general, their invented spellings followed typical developmental stages, e.g. from preliterate word knowledge, to alphabet names, and more advanced spelling patterns (Henderson, 1985). They also progressed in visual recall skills from looking ahead to the next letter before it vanished, to recalling a word recently seen, to recalling a word seen some time before.

Certain features of a word seemed to make its spelling easier. In general, the fewer the letters in a word the easier the spelling. Familiarity helped. Subsequent occurrences of a word were often spelled more easily than the first occurrence. Phonetic regularity in the spelling of a word also seemed helpful, particularly for Mark who had relatively advanced reading skills. It was probably not as much of an influence as

it might have been on the spelling of the other children since the programs emphasized a visual rather than a phonetic approach to spelling. With a visual emphasis, spelling should be easier when the children can recognize the morphemes or meaningful units in a word (see Radebaugh, 1985). However, there was not much opportunity for this to occur since the program vocabulary was limited and since inflected endings were introduced late in the study.

Mark, who could read the vocabulary words from the beginning, had well-developed reading responses to words. He attended well to their more significant features. For example, in saying the letters of a word aloud he might say the first letter, then the last letter, and then the middle letter, before correcting himself. Although he would study a word intently before it vanished, he had difficulty in recalling more than four letters. This suggested that he might have been relying on a strategy that was more efficient for reading than it was for spelling. He seemed to benefit the most from adopting overt oral rehearsal skills. A strategy for grouping letters into "chunks" for easier recall also seemed to help. When he was prompted to pause between clusters of letters he said aloud, his performance in spelling words of more than four letters improved.

Given his advanced reading skills, Mark understandably had more developed skills in inventing spellings than the other children, but he did not readily use them. Since he could read back whatever he wrote, he was often immediately aware of

whether he had written the standard spelling or not, and the standard spelling was what he wanted. He often preferred to copy a word and be sure that it was correct.

Examples of Mark's invented spellings can be seen in the sentences he wrote for his pictures: ISARATBZZZS for "There is a rain blizzard storm" (2/11) and TEH CAY IH CF THKK BN for "The cat is chasing the bird" (2/25). Progress in his spellings is shown in his writing of the dictated sentence THE GIRL SEES THE DOG on the pre- and posttests: from GRCDO (9/18) to G THG GRLSEZDOG (10/25) and THE G SEE THE DOG (4/24). These examples illustrate both phonetic (Z for S in "sees") and visual substitutions (Y for T in "cat") which are quite reasonable. The Y, for example, is not only visually similar to T, it is also directly next to it on the keyboard.

The stories Mark dictated for his pictures showed an increasingly integrated organization, from a simple listing to a thematic beginning, middle, and ending:

> "This is a flower and this is the water and this is a cat and this is two suns" (9/19).
>
> "The horse is galloping in the field. He is galloping to the barn. The cow is trying to get to the grass. He can't get there because he is too slow" (3/27).
>
> "The boy and girl watched the sun go down. The boy picked a flower for the girl. They went in the house and ate dinner" (5/2).

As shown in these examples, the fact that words like "galloping," "watched," and "dinner" were not in the program

vocabulary did not deter Mark from using them. Nor did he ever have any difficulty in reading back these words aloud at any time, even several weeks after they were written down.

In contrast to Mark, Judy had few reading skills in the beginning. However, she was the quickest to exhibit new spelling strategies, which we would then pass along for the other children to try. She would often say aloud what she was doing, like "I'm looking ahead to see what the next letter is." She was also the first to show overt rehearsal and pauses within the rehearsal of longer words. She seemed to take pride in her developing spelling skills, volunteering when she knew how to spell a longer word like "flower" and showing her independence of further help. For example, she might turn a card over after she had looked at a word, showing she was confident she could successfully spell the word now without looking again. By the time she wrote her last sentence, THE BOY AND GIRL ARE WALKING ON THE ROAD AND THEY SEE A DOG, she only needed help for the O in ROAD and THEY, a word which was not in the program vocabulary.

By the end of the study, Judy could regularly read aloud anything she wrote, whether an isolated spelling word or a sentence. As a further assessment of her reading skills, she was tested with sentences and separate words on cards. These sentences included old sentences from her stories, new ones that were constructed from the program vocabulary, and new ones with words outside the vocabulary. The word cards contained a selection of words from the vocabulary, words outside the

vocabulary but used in her sentences, and new words. The cards were presented to her separately without any supporting graphics. In general, she could read aloud the program vocabulary words in sentences and word cards with little difficulty, even when the sentences were entirely new to her. For example, she read the sentence THE FLOWER IS IN THE BOX easily even though she had never written it or seen it before. In addition, she indicated sensitivity to context clues in identifying words outside the program vocabulary, e.g. THEY and OFF.

Overall, Judy went through the following stages in reading words aloud. At first, as the instructor pointed to each word in sequence, reading it aloud if she was hesitant, there were only a few words that she could say, even on rereading. Then she became increasingly accurate in rereading all the words of the story from the printout. This might be referred to as a "memorized" reading of the same words, in the same sentences, and in the same context. Then she showed that she could read the same words (words she had read aloud before) in new sentences (new arrangements of the words). She also showed the beginnings of reading aloud new words (words not read aloud before) in new sentences.

An anecdotal report indicated that she was also using word attack skills outside of our instructional setting to extend her vocabulary. Her mother, for example, mentioned that when Judy read the sign HOUSE OF CARDS out loud, Judy said she knew CARDS

because it was like CAR. And of course HOUSE was a word in the program vocabulary.

The progress of the other two children, Kevin and Karen, who spent only one semester on the programs was similar to Judy's progress in her first semester. Both showed steadily increasing gains in spelling the program vocabulary. But they did not reach the point where they could spell most if not all of the program vocabulary words when writing complete sentences as Judy eventually did.

Kevin's work on the programs was restricted to the first semester in order to see how he would progress the following semester after we stopped working with him. The follow up assessment made at the end of the second semester indicated that he had pretty much retained what he had learned. In some items Kevin continued to make further progress while he was off the programs; however, this progress was less overall than it was in the first semester when he was on the programs. In naming isolated words on cards, Kevin progressed from no response (9/20) to BOY CAT DOG GIRL HOUSE TO and TREE (10/26) and BOY CAT DOG GIRL HOUSE TO and TREE again (4/24). In pointing to words named "at random" in the sentence THE BOY AND GIRL WALK, he progressed from no response (9/20) to identifying BOY AND GIRL WALK (10/26) and THE BOY GIRL (4/24). In writing the dictated sentence THE GIRL SEES THE DOG, he progressed from OIUY T (9/20) to GL GOD (10/26) and GIR HITDOG (4/24).

We only worked with Karen during the second semester, but we pretested her at the beginning of both the first semester and

second semester to see what her gains would be before we worked with her. In naming isolated words on card, she progressed from CAT (9/20) to BOY CAT DOG GIRL (2/4) and BOY CAT DOG GIRL HOUSE RUN SEE TO TREE and WALK (4/24). In reading aloud the sentence THE GIRL WALKS WITH THE DOG, she progressed from no response (9/20) to saying "water" for WALKS (2/4) and saying "The girl was with the dog" (4/24). In writing the dictated sentence THE GIRL SEES THE DOG, she progressed from MN (9/20) to G DCBMMNJB (2/4) and GCCCDOG (4/24). In general, she showed some gains in most of the items from 9/20 to 2/4. These gains reflect what her home and nursery school environment was providing her. However, she showed the greatest gains when she was working on the programs between 2/4 and 4/24, which was also a shorter period of time. It was also during this time that Karen showed a steadily increasing ability to read back the sentences she dictated or wrote. The number of words in her dictated text made a difference here. On a percentage basis, she was able to read shorter texts more accurately than the longer ones. Since she tended to dictate briefer texts in the later part of the semester, she may have anticipated writing or reading those texts and simplified the task for herself.

Program Changes

Several changes were made in the programs to make them easier for the children. Many programs that were too difficult or unproductive were abandoned if they could not be sufficiently corrected. Sometimes the adjustments were minor. The duration that a word remained on the screen, for example, was increased

in time from 2 to 4 and 5 seconds for the longer words when it became clear that the children wanted more time for inspection. At times, for example, they held down the RETURN key for help so that the word would remain on the screen.

More substantial changes were made in the program vocabularies. The children had difficulty composing pictures which were not easy to relate thematically. And Vocabulary II was changed in the direction of more thematic continuity after Mark was shown some new words and commented that they were "country words." It also became apparent that the children needed to have more exposure to spelling the inflected forms of verbs if they were to write their own sentences. Instead of using briefer verb forms, the children often dictated sentences in the present progressive tense with _is_ or _are_ and a verb with the _-ing_ inflection. And these forms were introduced into the spelling programs.

Changes were also made in the manner in which the vocabulary words were displayed for the spelling programs and in the manner in which feedback was given for correct responses. In the beginning two different methods were used with a fairly wide gap in recall demands. In the easier recall demands of the LETTER-SEQUENCE program, the word was displayed with one letter missing at a time after another, and each correct letter typed by the child remained on the screen. In contrast, the early SPELL programs vanished the word entirely after a brief display, and no feedback was given until the child had finished typing in all the letters for the word. If there was an incorrect letter,

all the letters in the child's response vanished and the child needed to write all the letters again from the beginning. There was clearly a big jump in recall demands when children went from the LETTER-SEQUENCE to the SPELL program.

To make this transition easier, a SYLLABLE-SEQUENCE program was developed that displayed the word with one group of letters missing after another, and each correct letter typed in remained on the screen. The value of this approach was called in doubt, however, by Judy's increasing difficulties with this program, which was discontinued in the later part of the project. See Judy's chart at the top right corner of Figure 4 for 10/22, 10/29, and 11/26.

Another change was made later on to lessen the recall demands in the SPELL programs. After the initial presentation of the word vanished, each correct letter that was then typed in remained on the screen, and immediate feedback was given as soon as an incorrect letter was typed in. Previously, feedback was not given until the entire word had been typed in, and all the letters vanished if an incorrect letter had been typed so that the child had to start all over again. The recall demands for two-letter words with the later SPELL programs was now close to that for the LETTER-SEQUENCE program. Mark's difficulty in spelling words of more than four or five letters subsequently suggested a separation of the SPELL programs on the basis of the number of letters in the vocabulary words. Mark's improved performance when this was done near the end of the project

suggests doing this on a systematic basis from the beginning in a future application.

Procedural Changes

The greatest adjustment in procedures was made for the children's writing of sentences. The task of composing a sentence while writing it was a demanding one. So we broke it up into two steps. First the child would compose the sentence in oral form, which was written down. Then the sentence was dictated back a word at a time for the child to write. The child could then focus exclusive attention on the spelling of each word. At first we simply urged the children to invent their best guesses for a word they were unsure of. The children, however, would often puzzle over this task for an unduly long time. We then gave them the option of looking at the word on a card after a brief opportunity to invent a spelling. This moved the writing along faster.

Another problem developed with the open-endedness of the task. At first the children were simply encouraged to come up with something to write on their own. They could use words for their sentences and stories which were not in the program vocabulary and often did, so much so that the subsequent spelling demands in writing their sentences were often quite difficult. As indicated above, one approach to resolving this problem was to include more words within the program vocabulary which they were likely to use. Another approach was to present the children with the words they had just written for a spelling program or a picture composition and request that they compose a

sentence using these words. The children still had the option of introducing any words they wanted, but it was now easier for them to stay within a spellable vocabulary.

Changes were also made in the procedures for writing isolated words in order to make their recall easier. As mentioned earlier with Judy, a particular prompt might be suggested by something a child had said or done on a previous occasion. The prompt was then introduced more systematically on subsequent occasions when it seemed needed. In the LETTER-SEQUENCE programs, for example, the children were prompted to "look ahead" to the next letter. In the SPELL programs the children were prompted to say the letters in the word aloud when it was flashed on the screen as well as to pause between groups of letters in the longer words.

Discussion

Although necessary causal connections between specific components of instruction and student achievement cannot be identified, there are reasons for attributing at least partial efficacy to the instructional conditions as a whole. For example, two of the four children were pre- and posttested at counterbalanced, different times while they were off the programs. The gains for Kevin in the first semester when he was on the programs were greater than in second semester when he was off the programs (see Table 2). Similarly, the gains for Karen during the second semester when she was on the programs was greater than in the first semester when she was off the programs (see Table 3). It is unlikely that influences external to the

instructional condition would entirely account for these differences. This suggests that at least some of the improvement in the children's performance might reasonably be attributed to the instructional condition. In addition, the specificity with which the children picked up the spelling of the vocabulary words is unlikely to be explained by their exposure to spelling instruction at home or in the preschool program, especially since there was little evidence of any standard spelling of words outside the program vocabulary. In particular, Judy, who began with few writing and reading skills, acquired a substantial portion of a small writing and reading language system.

In fact, Judy's progress in standard spelling exceeded that of Mark, who from the beginning could read any of the vocabulary words and any of the words he dictated whenever he was asked. While Mark did increase his accuracy in spelling words of up to four letters without help and in spelling his dictated sentences which incorporated words from his relatively large reading vocabulary, we found it somewhat surprising that his advantage over Judy in reading did not translate into an advantage in learning the standardized spellings of the program vocabulary. Abductively, this suggested two hypotheses. 1) Perhaps the recall ability for standard spelling depends on a maturational development which Mark had not yet reached. And/or 2) perhaps reading ability introduces an additional complexity to the spelling task. That is to say, the additional phonological and analogical alternatives for spelling that a reader is aware of

might increase the initial complexity in recalling standardized spelling even if this greater awareness of alternatives was more promising in the long run for accurate spelling. Mark might have benefitted then from having more time to inspect the spelling words before they disappeared.

Although there is little implication for program changes in addressing the first hypothesis, there is something that can be done for the second. Instead of having the spelling word disappear on the screen after a set time, it may be better to have the word remain on the screen until the child presses the first letter in order to accomodate a wider range of ability levels. In addition, there may be little need to move from one type of visual display to another as in going from a LETTER-SEQUENCE to a SPELL program. One basic stimulus format like that in the later SPELL programs may be sufficient. This would allow a more gradual transition from easy to difficult spelling tasks by simply increasing the number of letters in the spelling vocabulary. These and other adjustments are being explored in subsequent versions of these programs (Moxley, 1986).

In applications to the classroom, these programs would lend themselves to being included within an ongoing language experience approach to reading. Using the word processing features of the computer would be a particular advantage for those children who find handwriting substantially more demanding than pressing the keys on a keyboard. In addition, many activities similar to the program activities might be done with

paper and pencil. For example, the teacher might use cutouts of computer pictures for words or children's drawings for words to make word-picture stories of child-dictated words and child-selected pictures. The child dictates the text for the teacher to write down and then places a cutout of a word-picture at the appropriate spot, dictates more text, and places another word-picture, and so on. This active involvement with the ongoing production of the text seems to produce longer narratives than less involving language experience activities (Poling, 1985; Warash & Poling, 1986).

Additional linkages between the computer work and classroom activities can be established by using a similar vocabulary for handwriting and for classroom texts. It might even be possible to select or design children's books which gradually expand upon this basic literacy vocabulary. Designed books might use computer pictures for illustrations, perhaps even samples of children's computer pictures and stories. Some of these texts could be presented on the screen and read to the child by a speech synthesis unit, one word highlighted and spoken aloud for each press of the space bar, one word after the other.

The children's writing on the computer is itself a source of classroom reading material. Using the computer for "desktop publishing," permanent collections of the children's work can be made in personal booklets, classroom anthologies, and class newspapers. There might be a listening post for hearing these stories read, perhaps from the computer's speech synthesis unit,

or a time in class when children could read their stories to each other.

By integrating classroom-wide activities with the microcomputer activities, a fuller advantage can be taken of the computer as a producer of writing and reading materials, feedback provider, and recordkeeper. In addition, establishing the computer as an integral part of children's learning environments provides an opportunity for its further exploration. While it is still difficult to foresee where this exploration will lead, we have presented here some of the results from using an open-ended program for developing early writing and reading. If these results look promising, they are available for others to use in advancing this exploration a little further.

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Authors' Note

A free copy of the current version of these programs and a guide may be obtained by sending a blank disk with a stamped and addressed return envelope to Roy Moxley, 604 Allen Hall, West Virginia University, Morgantown, WV 26506-6122. A copy of the silent version will be sent with simple directions for conversion to speech synthesis with the Echo General Purpose Unit. You will need to load Terrapin Logo 2.0 or 3.0 first on an Apple II+ or IIe in order to run these programs without modification. The authors would also like to acknowledge the cooperation of Bobbie Gibson Warash, Director of the West Virginia University Nursery School, in helping with the arrangements for this study.

Table 1

Examples of Letter Displays in the SPELL Program

Steps	Letter Display	Explanation
1	DOG	The spelling of the word appears briefly.
2		The word vanishes.
3		The first letter is typed correctly.
	D	The correct letter remains.
4	DOG	The original spelling reappears when
	DA	an error is made.
5		Error and original spelling vanish.
	D	The correct letter remains.
6		The second letter is typed in correctly.
	DO	
7	DOG	The original spelling is reshown and
	DOG	highlighted when the spelling of the word is successfully completed.

Table 2

Pre-posttest Results for Kevin
(On programs: 9/18 to 12/5; off programs: 12/5 to 4/24)

---

1. Matches: SHAPES PICTURES LETTERS WORDS

9/18	+	+	+	+
10/26	+	+	+	+
4/24	+	+	+	+

2. Names Letters:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
9/18	+	+		+	+		+	+	+		+	+		+	+						+		+		-	
10/26	+	+		+	+		+	+	+		+	+		+	+			+	+		+		+		+	
4/24	+	+		+	+		+	+			+	+		+	+			+	+		+		+		+	

3. Names isolated words on cards:

	AND	BOY	CAT	DOG	GIRL	HOUSE	RUN	SEE	THE	TO	TREE	WALK
9/18	-	-	-	-	-	-	-	-	-	-	-	-
10/26	-	+	+	+	+	+	-	-	-	+	+	-
4/24	-	+	+	+	+	+	-	-	-	+	+	-

4. Circles word boundaries:

9/18	-
10/26	+
4/24	+

5. Points to words named "at random" in sentence:

	THE	BOY	AND	GIRL	WALK
9/18	-	-	-	-	-
10/26	-	+	+	+	-
4/24	+	+	-	+	-

6. Names words pointed to "at random" in sentence:

	THE	DOG	SEES	THE	HOUSE
9/18	-	-	-	-	-
10/26	-	+	-	-	+
4/24	-	+	-	-	+

7. Reads sentence aloud:

	THE	GIRL	WALKS	WITH	THE	DOG
9/20	-	-	-	-	-	-
10/26	-	+	-	-	-	+
4/24	-	+	-	-	-	+

8. Makes a story from "random" array of word cards (BOY CAT DOG GIRL HOUSE RUN SEE)
   9/20 (could not do)
   10/26 "A dog's going in the house and boy is going out of house."
   4/24 "The girl walks with the ran."
9. Types to dictation ("The girl sees the dog"):
   9/20 OIUY T
   10/26 GL GOD
   4/24 GIR HITDOG
10. Free writing:
    9/18 NBVVCXZSDFGGHJKLL;IUYT
    10/26 FGHJKIUY GODBBHABGCGERJKIUSAPOGPOIUYTREQASDFGHH ("dog" "USA")
    4/24 HOTBASEWYUGED

Table 3

Pre-posttest Results for Karen
(Off programs: 9/20 to 2/4; on programs: 2/4 to 5/2)

---

1. Matches: SHAPES PICTURES LETTERS WORDS

9/20	+	+	+	+
2/4	+	+	+	+
4/24	+	+	+	+

2. Names letters:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
9/20	+	+		+	+		+	+	+		+	+		+	+			+	+		+		-		+	
2/4	+	+		+	+		+	+			-	+		+	+			+	+		+		+		+	
4/2	+	+		+	+		+	+			+	+		+	+			+	+		+		+		+	

3. Names isolated words on cards:

	AND	BOY	CAT	DOG	GIRL	HOUSE	RUN	SEE	THE	TO	TREE	WALK
9/20	-	-	+	-	-	-	-	-				
2/4	-	+	+	+	+	-	-	-	-	-	-	-
4/24	-	+	+	+	+	+	+	+	-	+	+	+

4. Circles word boundaries:

9/20	-
2/4	+
4/24	+

5. Points to words named "at random" in sentence:

	THE	BOY	AND	GIRL	WALK
9/20	-	-	-	+	-
2/4	-	+	-	+	-
4/24	-	+	-	+	+

6. Names words pointed to "at random" in sentence:

	THE	DOG	SEES	THE	HOUSE
9/20	-	+	-	-	-
2/4	-	+	-	-	+
4/24	+	+	-	-	+

7. Reads sentence aloud:

	THE	GIRL	WALKS	WITH	THE	DOG
9/20	-	-	-	-	-	-
2/4	-	-	"water"	-	-	+
4/24	+	+	"was"	-	-	+

8. Makes a story from "random" array of word cards (BOY CAT DOG GIRL HOUSE RUN SEE):

9/20	"Y" "O"
2/4	"H" "B" "G" "D"
4/24	"Run boy girl house see"

9. Types to dictation ("The girl sees the dog")

9/20	MN
2/4	G DCBMMNJB
4/24	GCCCDOG

10. Free writing:

9/20	KARNE (reversed last two letters of her name)
2/4	KAREN CAT F
4/24	KAREN MOMDADMATT

Table 4

Pre-posttest Results for Mark
(On programs: 9/19 to 5/2)

---

1. Matches: SHAPES PICTURES LETTERS WORDS

9/18	+	+	+	+
10/25	+	+	+	+
4/24	+	+	+	+

2. Names letters:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
9/18	+	+		+	+		+	+	+		+	+		+	+			+	+		+		+		+	
10/25	+	+		+	+		+	+	+		+	+		+	+			+	+		+		+		+	
4/24	+	+		+	+		+	+			+	+		+	+			+	+		+		+		+	

3. Names isolated words on cards:

	AND	BOY	CAT	DOG	GIRL	HOUSE	RUN	SEE	THE	TO	TREE	WALK
9/18	+	+	+	+	+	+	+	+	+	+	+	+
10/25	+	+	+	+	+	+	+	+	+	+	+	+
4/24	+	+	+	+	+	+	+	+	+	+	+	+

4. Circles word boundaries:

9/18	+
10/25	+
4/24	+

5. Points to word named "at random" in sentence:

	THE	BOY	AND	GIRL	WALK
9/18	+	+	+	+	+
10/25	+	+	+	+	+
4/24	+	+	+	+	+

6. Names words pointed to "at random" in sentence:

	THE	DOG	SEES	THE	HOUSE
9/18	+	+	+	+	+
10/25	+	+	+	+	+
4/24	+	+	+	+	+

7. Reads sentence aloud:

	THE	GIRL	WALKS	WITH	THE	DOG
9/18	+	+	+	+	+	+
10/25	+	+	+	+	+	+
4/24	+	+	+	+	+	+

8. Makes a story from "random" array of word cards (BOY CAT DOG GIRL HOUSE RUN SEE):

9/18	"House walk run boy dog see."
10/25	"Boy ran." "Boy walk."
4/24	"The house was with the boy and girl."

9. Types to dictation ("The girl sees the dog"):

9/18	GRCDO
10/25	G THG GRLSEZDOG
4/24	THE G SEE THE DOG

10. Free writing:

9/18	GFD
10/25	HGYTFDESXCVVBHGFRESCVBGBNHBNMJHYFDESAQ3E
4/24	MARK IS WAKG ("Mark is walking")

Table 5

Pre-posttest Results for Judy
(On programs: 9/19 to 5/1)

---

1. Matches: SHAPES PICTURES LETTERS WORDS

9/17	+	+	+	+
10/25	+	+	+	+
4/24	+	+	+	+

2. Names letters:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
9/17	+			+				+			+	+	+	+	+			+	+		+		+		+	
10/25	+	+		+	+			+	+		+	+	+	+	+			+	+		+		+		+	
4/24	+	+		+				+	+		+	+	+	+	+			+	+		+		+		+	

3. Names isolated words on cards:

	AND	BOY	CAT	DOG	GIRL	HOUSE	RUN	SEE	THE	TO	TREE	WALK
9/17	-	-	-									
10/25	-	+	+	+	+	+	-	-	-	-	+	-
4/24	+	+	+	+	+	+	"ran"	+	+	+	+	"water"

4. Circles word boundaries:

9/17	+
10/25	+
4/24	+

5. Points to words named "at random" in sentence:
THE BOY AND GIRL WALK

9/17	-	-	-	-	-	
10/25	+	+	+	+	-	
4/24	+	+	+	+	+	(named instead of pointed)

6. Names words pointed to "at random" in sentence:
THE DOG SEES THE HOUSE

9/17	-	-	-	-	-
10/25	-	+	-	-	+
4/24	+	-	+	+	+

7. Reads sentence aloud (
THE GIRL WALKS WITH THE DOG

9/17	-	-	-	-	-	-
10/25	+	+	+	-	+	+
4/24	+	+	"walk"	-	+	+

8. Makes a story from "random" array of word cards (BOY CAT DOG GIRL HOUSE RUN SEE)

9/17	(COULD NOT DO)
10/26	"He was running in the house."
4/24	"The girl is seeing the house.

9. Types to dictation ("The girl sees the dog."

9/17	(could not do)
10/25	FHJGYGHC ,UDOG
4/24	THE GIRL SEE THE DOG

10. Free writing:

9/17	(could not do)
10/25	GTYRUWREDFSHAWWRTJUDYEWFRTBVDFDFRGGTED ("water Judy")
4/24	THE GIRL IS SEE THE HOUSE

Table 6

First Semester Composing Sentences : Kevin

Date	Sentences	Program
9/24	Dictated: "A cat a boy a dog a house and water."	FIL
	Dictated: "The cat and the dog and a house and a boy and a girl are walking."	FIL
9/26	Dictated: "There's a house and a tree and a flower and a dog and a boy and a girl and a house. The boy and girl are standing. And the flower and the tree."	FIL
10/1	Dictated: "A girl and boy are standing and a flower and a tree and a sun."	FIL
10/10	Dictated: "The boy and girl are standing on the house. The dog is walking and the bird is flying. The flower is standing by the house."	FIW
10/15	Dictated: "There's an octopus and a chair and a pig and bed and a sun and a apple and a chair and a table. He's eating all the apple and he was jumping to get it."	FIIW
10 17	Dictated: "The octopus and the pig. They are standing in the water because he is hot. The apple s somewhere."	FIIW
10/24	Wrote: MONKEY JUMP THE PIG. THE PIG C EAT COOKIE.	FPW
10/29	Dictated: "There's a table under the pig's nose. The water is going on the chair. And the apple is under the bed. The pig is going to put the table on the octopus's head."	FIIL
11/26	Dictated: "There is a sun and a half of a tree. The boys are standing. The dog is on the roof of the house. The sun is shining."	FIL
11/28	Wrote: THE GIRL RUN ON A GRASS	FPWI
12/3	Wrote: A GIRL RUNS TO THE HOUSE.	FPWI
12/5	Wrote: THE DOG WALKS TO THE BOYS AD GIRLS AD SEES THE TREE	FPWI

Table 7

Second Semester Composing Sentences: Karen

Date	Sentences	Program
2/4	Dictated: "The boy was swimming and the girl was just out of the house. The sun just came up. The cat was outside and the flower is growing."	FIL
2/13	Dictated:"The dog was going to get ready to go swimming. The girl was petting the cat. It was Christmas. The cloud and the boy were outside. That's all.	FIW
2/20	Dictated: "The dog saw somebody skiing. The girl was going to run to the ocean."	FIW
3/6	Dictated: "The cat was smelling the flower. And the girl was going in both of the houses and playing tag."	FIW
3/18	Dictated; "The cat lives in the house. The flower was right beside there and growing in the cat's garden. And a tree was there."	FIL
3/20	Dictated: "There was a tree on both sides. The girl and the boy were outside and the boy was jumping. And the sun was out. The girl was going inside the house."	FIW
3/25	Dictated: "The girl was by the house. And there is supposed to be a flower on the road."	FIW
4/1	Dictated: "The girl was jumping and she saw an apple. And that was a live apple that she never seen before."	FIIW
4/3	Dictated: "There was two kids and they were at the farm. They saw a pig and a horse.	FIIW
4/10	Dictated: "Once upon a time, there was a cow and he was eating hay."	FIIW
	Dictated: "Cow is eating hay."	
	*Wrote: COW IS <u>EATING</u> HAY	FPWII
4/15	Dictated: "A cat is kissing the boy."	
	Wrote: A CAT <u>IS</u> <u>KISSING THE</u> BOY	FPWI
4/17	Dictated: "There was a cat kissing the dog."	
	Wrote: <u>THERE</u> <u>WAS</u> A CAT <u>KISSING THE</u> DOG	FPWI
4/22	Dictated: "The girl was talking to the cat."	
	Wrote: <u>THE GIRL WAS TALKING TO THE</u> CAT	FPWI
4/29	Dictated: "The girl was climbing the star at night time."	
	Wrote: <u>THE</u> <u>GIRL WAS</u> C<u>LIMBING</u> THE <u>STAR</u> AT <u>NIGHT</u> <u>TIME</u>	FPWI
5/2	Dictated: "The cat was climbing the tree and the girl and boy are climbing the flower and they were climbing the water."	FIL

*The underlined letters were written after looking at a word card.

Table 8

First Semester Composing Sentences: Mark

Date	Sentences	Program
9/19	Copied: HELLO, own name, DOG, SEE, HOUSE, BOY from self-selected cards. Dictated "This is a flower and this is the water and this is a cat and this is two suns."	FIL
9/24	Copied: HELLO, TREE, SQUARE, RUN from self-selected cards. Wrote: BOY IS IN THE HOUSE with much prompting	(none)
9/26	Copied: DOG, CAT, GIRL, BOY, BIKE, and own name from self-selected cards. Wrote: BOY IS IN SEE HOUSE THE with less prompting.	(none)
9/27	Dictated: "Two suns. The mommy and daddy are in the pool. The dog's on the porch. There's a house."	FIL
10/1	Dictated: That's Tucker. He's light brown. He's black. And that's all. That's my brother, [brother's name]."	FIL
10/3	Dictated: "They are watching Tucker. The tree house is right next to them. We have two houses. One is in the tree. Tucker is trying to eat the bird	FIL
10/8	Dictated: "There is a cat in the tree. There is water. There is a flower. If it was a pile of dirt or leaves, you could jump in them. The sun is up above. The bird is flying."	FIW
10/10	Dictated: "There's an octopus and there's an apple hitting the octopus in the head. There's sand. There's a bed." Copied first three words afterwards.	FIIW
10/15	Dictated: "Two chestnut trees are standing still and making chestnuts fall. My mom and me and my brothers are in the house. My dad's watching Tucker. One of my friends cuts the grass." Copied first seven words afterwards.	FIW
10/17	Dictated: "There is a pig taking a bath and there is grass and there is a sun. There is a bunk bed. There is an apple and a hill."	FIIW
10/22	Wrote: BIRD WA WALKS GRASS HOUSE IIS UN SUN.	FPWI
10/24	Wrote: THE MONKEY AND THE PIG MARK SIT ON THE HILL.	FPWII
10/29	Wrote: SUN MAKES THE GRASS GROW. THE PIG JUMPS ON THE GROUND.	FPWII
10/30	Wrote: HALLOWEEN A GOBLIN N APPLE DROPS ON THE HEAD.	(none)
11/26	Wrote: A BIRD RUNS TO THEW WATER.	FPWI
11/28	Wrote: A BIRD WAALK3 3 TO THE TREE.	FPWI
12/3	Wrote: THE DOG WNET TO THE HOUSE TO THE FWD. ("food")	FPWI
12/5	Wrote: MY DAD TAKR WALK TO THE HOUSE TO THE FED. ("My dad and Tucker walk to the house to the food.")	FPWI

Table 9

Second Semester Composing Sentences: Mark

Date	Sentences	Program
2/4	Dictated: "The boy and the girl are taking the dog for a walk."	
	Wrote: THE BY THE GL GIDRT UKTHE D F A W	FIL
2/11	Dictated:"There is a rain blizzard storm."	
	Wrote: ISARATBZZZS	FIW
2/20	Dictated: "They are in the night and there is a storm going on. There is rain and snow. There is a star and a moon."	
	Wrote: TRGHKJHI R N TE N (for first sentence)	FIW
2/25	Dictated: "The cat is chasing the bird."	
	Wrote: TEH CAY IH CF THKK BN	FIW
2/27	Dictated: "The car is on the road. There is rain snow."	FIW
3/4	Dictated: "Girl chases dog."	
	Wrote: GIRL CA DOG	FPWI
3/18	Dictated: "Mark is walking Tucker in the front yard."	
	Wrote: MARK IN W T IN THE F YRD	FPWI
3/20	Dictated: "They are driving in the night. There is a rainy storm going on."	FIW
3/25	Dictated: "Samantha is throwing a frisbee."	
	Wrote: SAMATAT IS TA A FR	(none)
3/27	Dictated: "The horse is galloping in the field. He is galloping to the barn. The cow is trying to get to the grass. He can't get there because he is too slow."	FIIW
4/1	Dictated: "Tucker is chained up."	
	Wrote: THAIKR IS C UP	FPWII
4/10	Dictated: "The pig is at the barn."	
	*Wrote: THE PIG IS AT THE <u>BARN</u>	FPWII
4/15	Dictated: "The boy is going to the house. The boy met a flower there."	
	Wrote: THE BOY IS <u>GIOG</u> TO THE HOUSE THE BOY <u>MET</u> A <u>FLOWR THERE</u>	FPWI
4/17	Dictated : "The flower was growing at the house."	
	Wrote: THE F<u>LOWER</u> WAS G<u>ROWING</u> AT THE HOUSE.	FPWI
4/22	Dictated: "We were driving in the night. There was a rainy snowy storm going on."	FIW
	Dictated: "The star and moon were lonely."	
	Wrote: THE <u>STAR</u> AND MOON <u>WERE LONELY</u>	FPWI
4/29	Dictated: "The boy walks with the girl."	
	Wrote: THE BOY W<u>ALKS</u> W<u>ITH</u> THE G<u>IRK</u>	FPWI
5/1	Dictated: "The boy was running over the hill."	
	Wrote: THE BOY <u>WAS</u> R<u>UNNING</u>	FPWI
5/2	Dictated: "The boy and girl watched the sun go down. The boy picked a flower for the girl. They went in the house and ate dinner."	FIL

*The underlined letters were written after looking at a word card.

Table 10

First Semester Composing Sentences: Judy

Date	Sentences	Program
9/19	Copied: READ and own name. Dictated: "there's people in the house and there's some flowers."	FIL
9/24	Dictated: "It's a house. A cat a girl. The dog's in the water and so is the sun. Why should it be in the water? Don't ask me."	FIL
9/26	Dictated: "The girl is picking a flower. And the boy is by an animal, a cat."	FIL
10/1	Dictated: "The tree went backwards."	FIL
10/3	Dictated: "Here's the boy and here's the girl. The house was on the dog and the cat was up from the sun. The dog was smelling the flower.	FIL
10/8	Dictated: "I have three dogs. The flower went up to the sun and got burned. It's hot you know. There is just one cat.	FIW
10/10	Dictated: "The house. The cat on the dog. Then There's a half house. I made a flower and you know how to spell flower."	FIW
10/15	Dictated: "The pig is on the sun. The table is on the road. The water is in the bed. It is a water bed."	FIIW
10/17	Dictated: "The octopus is on the road and the car coming and it can't get through. There is water all over the street."	FIIW
10/29	Wrote: MONKEY AND PIG EAT APPLE AND COOKIES.	FPWII
11/26	Dictated: "It is a house and the boy is holding the girl's hand."	FIL
11/28	Wrote: JUDYR JUDY UH PU. JUDY ISP IS PU JUDY SEES HJP MJY HUYT HIKE.	FPWI
12/2	Wrote: THE BIRD WALKS TO MOUT MOUNTAINLAIR	FPWI

Table 11

Second Semester Composing Sentences: Judy

Date	Sentences	Program
2/4	Dictated: "There's one boy in the house. There's a cat in the house and a flower in the middle of the house."	
	Wrote: THS1 BOY GM ENJ HOUSE THSMB CAT NGN EHN HOUSE	FIL
2/11	Dictated: "The bird's in the rain. The sun's in the rain."	FIW
2/20	Dictated: "It is raining and snowing. The girl has an umbrella."	FIW
2/25	Dictated: "The bird was between the moon and the star."	
	Wrote: THE B R T THE MOON A D THE C	FIW
3/4	Dictated: "Bird is in the water."	
	Wrote: BIRD IS IN THE WTI WIHE	FPWI
3/18	Dictated: "The girl and the boy are touching the bird."	
	Wrote: THE GIRL AND THE BOY C C THE BIRD	FPWI
3/20	Dictated: "The boy and the house."	
	Wrote: THE BOY AND HOUSE	FIW
3/25	Dictated: "The boy and the girl is walking on the road."	
	Wrote: THE BOY DAN THE GIRL IS WALK W THE DO	FPWI
3/27	Dictated: "The barn and the cow. On the cow's ear is the box."	FIIW
4/1	Dictated: "She is sitting on a chair eating a cookie."	
	Wrote: HAY SI COOIE ON A C VS A COORIE	FIIW
4/3	Dictated: "The hills and the grass and fence are horse and the fence."	FIIW
4/10	Dictated: "The trees and the hills and the barn and the pig."	FIIW
	Dictated: "The pig was in the fence."	
	*Wrote: THE PIG <u>WAS</u> IN THE <u>FENCE</u>	FPWII
4/15	Dictated: "The girl is walking."	
	Wrote: THE GIRL IS WA<u>LKING</u>	FPWI
4/17	Dictated: "The flower was digged down in the grass."	FPWI
4/22	Dictated: "The girl is jumping on the road."	FIW
	Dictated: "The girl is jumping on the road."	
	Wrote: THE GIRL IS <u>JUMPING ON</u> THE <u>ROAD</u>	FPWI
4/30	Dictated: "The girl and boy are picking flowers on the grass."	
	Wrote: THE GIRL AND BOY ARE P<u>ICKING</u> FLOWERS ON THE GR<u>A</u>SS	FPWI
5/1	Dictated: "The boy and girl are walking on the road and they see a dog."	
	Wrote: THE BOY AND GIRL ARE WALKING ON THE R<u>O</u>AD AND <u>THEY</u> SEE A DOG	FPWI

*The underlined letters were written after looking at a word card.

Table 12

Reading Self-dictated Sentences: Karen

Date	Sentences	Program	% Correct
2/4	THE BOY WAS SWIMMING AND THE GIRL WAS JUST OUT OF THE HOUSE. THE SUN JUST CAME UP. THE CAT WAS OUTSIDE AND THE FLOWER IS GROWING.	FIL	19 (5/26)
2/20	THE DOG WAS GOING TO GET READY TO GO SWIMMING. THE GIRL WAS PETTING THE CAT. IT WAS CHRISTMAS. THE CLOUD AND THE BOY WERE OUTSIDE. THAT'S ALL.	FIW	14 (4/28)
2/27	THERE WAS CHRISTMAS AND THERE WAS RAIN AND SNOW.	FIW	22 (2/9)
3/6	THE CAT WAS SMELLING THE FLOWER. AND THE GIRL WAS GOING IN BOTH OF THE HOUSES AND PLAYING TAG.	FIW	37 (7/19)
3/18	THE CAT LIVES IN THE HOUSE. THE FLOWER WAS RIGHT BESIDE THERE AND GROWING IN THE CAT'S GARDEN. AND A TREE WAS THERE.	FIL	48 (11/23)
3/20	THERE WAS A TREE ON BOTH SIDES. THE GIRL; AND THE BOY WERE OUTSIDE AND THE BOY WAS JUMPING. AND THE SUN WAS OUT. THE GIRL WAS GOING INSIDE THE HOUSE .	FIW	19 (6/31)
3/25	THE GIRL WAS BY THE HOUSE. AND THERE IS SUPPOSED TO BE A FLOWER ON THE ROAD .	FIW	59 (10/17)
4/1	THE GIRL WAS JUMPING AND SHE SAW AN APPLE. AND THAT WAS A LIVE APPLE THAT SHE NEVER SEEN BEFORE.	FIIW	50 (10/20)
4/3	THERE WAS TWO KIDS AND THEY WERE AT THE FARM. THEY SAW A PIG AND A HORSE.	FIIW	65 (11/17)
4/10	ONCE UPON A TIME, THERE WAS A COW AND HE WAS EATING HAY.	FIIW	92 (11/12)
	COW IS EATING HAY.	FPWII	75 (3/4)
4/15	A CAT IS KISSING THE BOY.	FPWI	100 (6/6)
4/17	THERE WAS A CAT KISSING THE DOG.	FPWI	100 (7/7)
4/22	THE GIRL WAS TALKING TO THE CAT.	FIW	86 (6/7)
4/29	THE GIRL WAS CLIMBING THE STAR AT NIGHT TIME.	FPWI	100 (9/9)

The words that the child could read aloud correctly are underlined.

Table 13

Reading Self-dictated Sentences: Judy

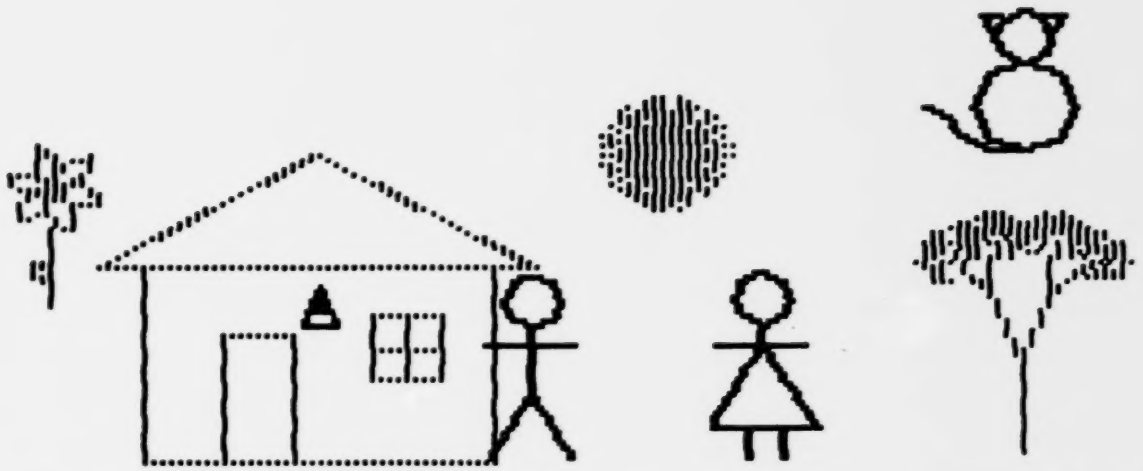
Date	Sentences	Program	% Correct
2/11	THE BIRD'S IN THE RAIN. THE SUN'S IN THE RAIN.	FIW	80 (8/10)
2/20	IT IS RAINING AND SNOWING. THE GIRL HAS AN UMBRELLA.	FIW	60 (6/10)
2/25	THE BIRD WAS BETWEEN THE MOON AND THE STAR.	FIW	77 (7/9)
3/4	BIRD IS IN THE WATER.	FPWI	100 (5/5)
3/18	THE GIRL AND THE BOY ARE TOUCHING THE BIRD.	FPWI	100 (9/9)
3/25	THE BOY AND THE GIRL IS WALKING ON THE ROAD.	FPWI	100 (10/10)
3/27	THE BARN AND THE COW. ON THE COW'S EAR IS THE BOX.	FIIW	58 (7/12)
4/1	SHE IS SITTING ON A CHAIR EATING A COOKIE.	FPWII	56 (5/9)
4/3	THE HILLS AND THE GRASS AND FENCE ARE HORSE AND THE FENCE.	FIIW	92 (11/12)
4/10	THE TREES AND THE HILLS AND THE BARN AND THE PIG.	FIIW	100 (11/11)
4/15	THE GIRL IS WALKING.	FPWI	100 (4/4)
4/17	THE FLOWER WAS DIGGED DOWN IN THE GRASS.	FPWI	100 (8/8)
4/22	THE GIRL IS JUMPING ON THE ROAD.	FIW	100 (7/7)
4/30	THE BOY AND GIRL ARE PICKING FLOWERS ON THE GRASS.	FPWI	100 (10/10)
5/1	THE BOY AND GIRL ARE WALKING ON THE ROAD AND THEY SEE A DOG.	FPWI	100 (14/14)

The words that the child could read aloud correctly are underlined.

```
GIRL [GH GH GIH HELP GIRH]
DOG [DP DP]
TREE [B M TH TRJ]
RUN [G RUH]
SEE [H SH HELP SR SR]
CAT [E]
HOUSE [J HM HM H, HOM HOM]
BOY [ ]
WALK [G WS WAH WAL,]
TREE [HELP HELP HELP HELP]
GIRL [ ]
SEE [HELP]
BOY [O O]
HOUSE [HELP HELP]
WALK [HELP WW HELP WAA HELP HELP]
CAT [CAY]
```

Figure 1. Example of a printout from a spelling program (Judy 10/10/84). Each spelling error and each request for help before the word was spelled correctly is listed within the brackets. Empty brackets mean the word was spelled correctly without errors and without help.

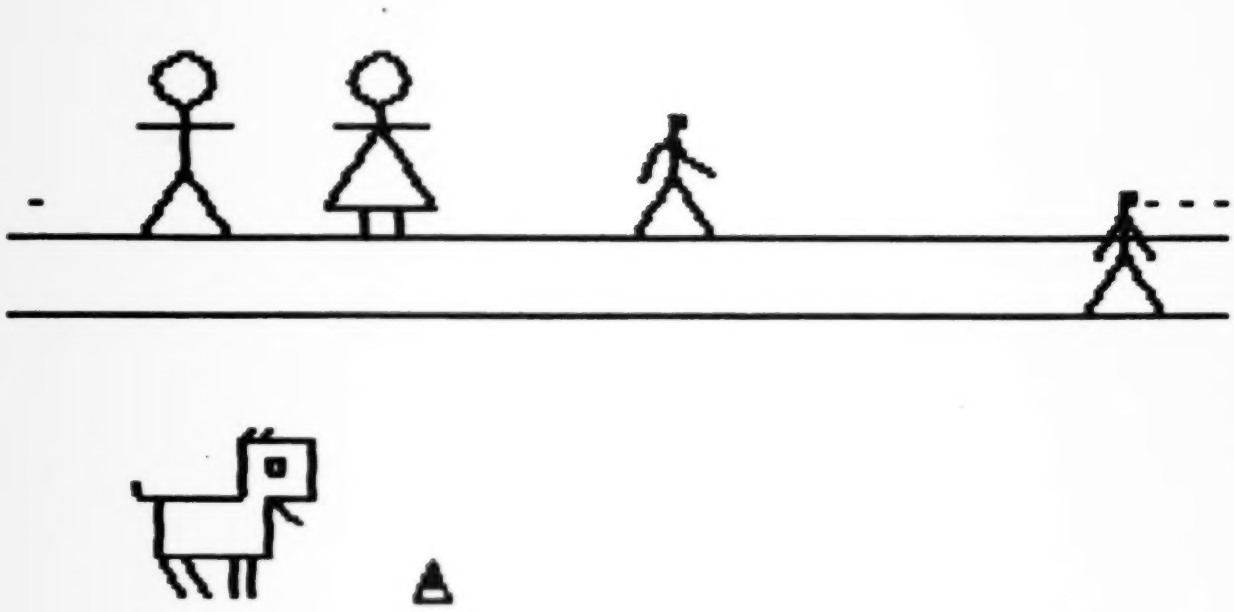
FASPICTURES I LETTERS (SOUND)



THE BOY AND GIRL WATCHED THE SUN GO DOWN. THE BOY PICKED A FLOWER FOR THE GIRL. THEY WENT IN THE HOUSE AND ATE DINNER.

Figure 2. Example of a printout for a FASPICTURES program (Mark 5/2/85).

FASPICTUREWRITING I (SOUND)



THE BOY AND GIRL ARE WALKING ON THE ROAD AND THEY SEE A DOG

Figure 3. Example of a printout for a FASPICTUREWRITING program with the sentence written by the child (Judy 5/1/85).

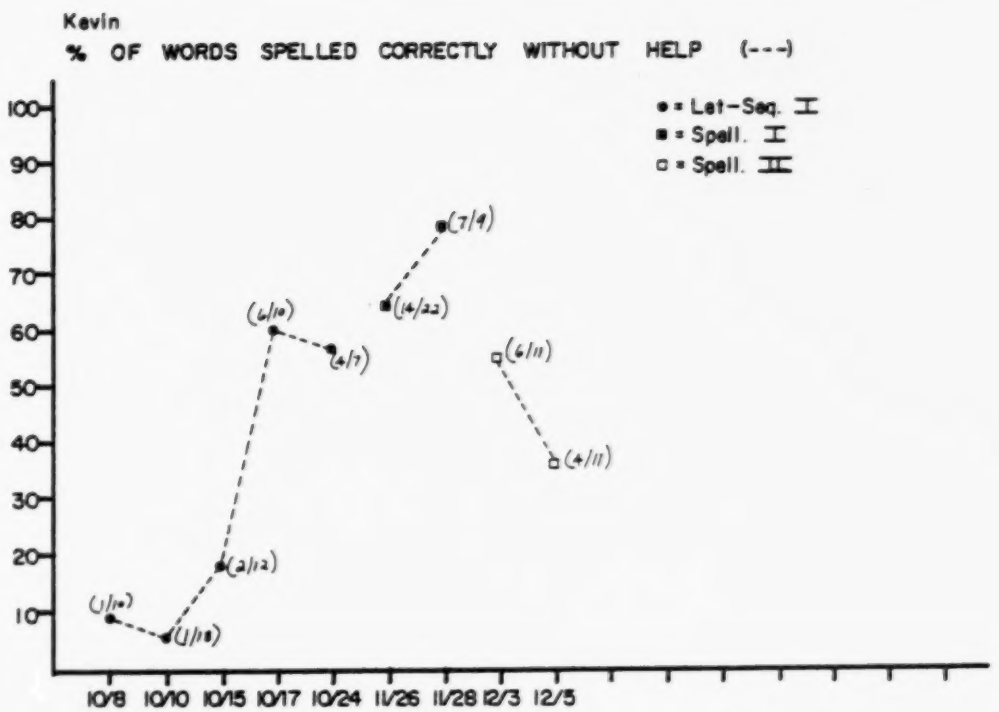


Figure 4. Kevin's spelling progress in the first semester. The number correct and the number of opportunities are in parentheses.

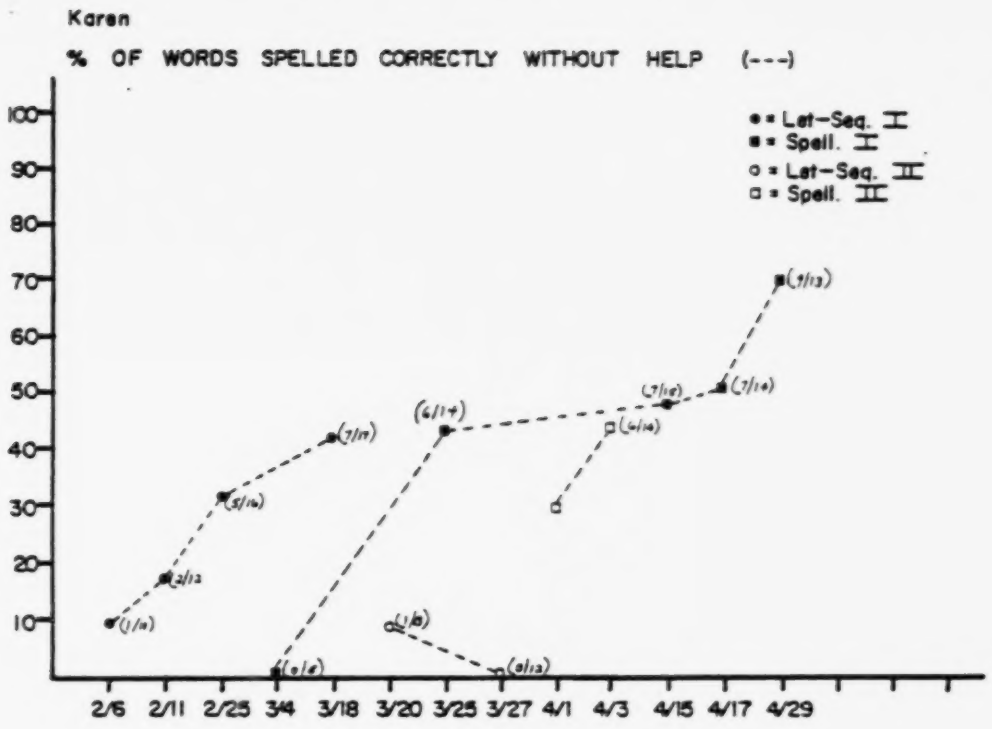
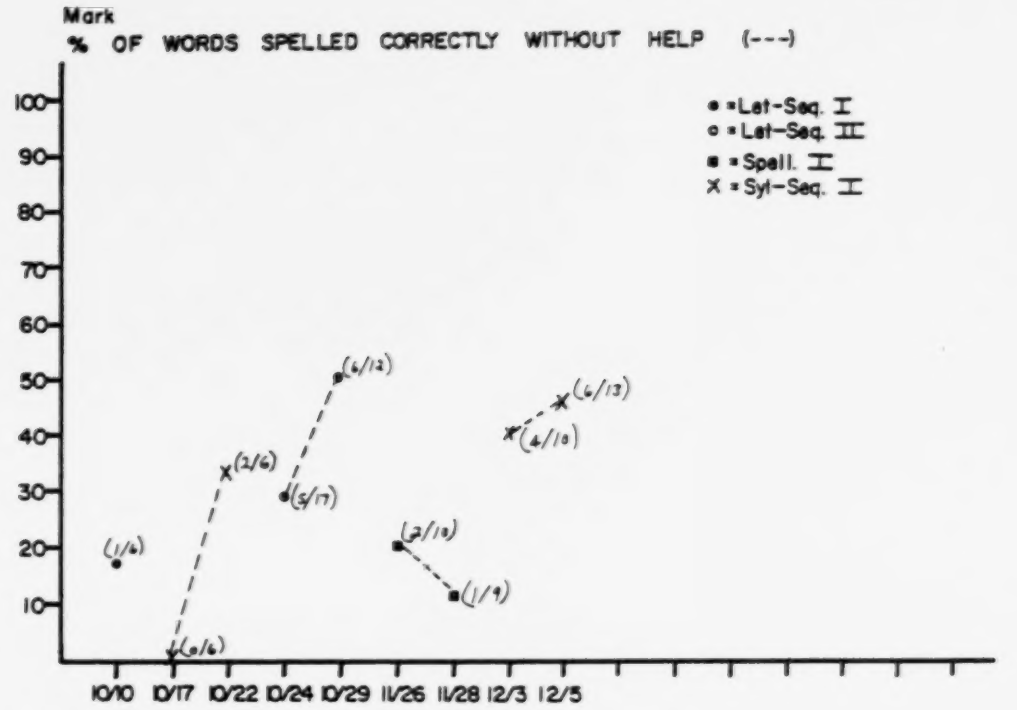


Figure 5. Karen's spelling progress in the second semester. The number correct and the number of opportunities are in parentheses.



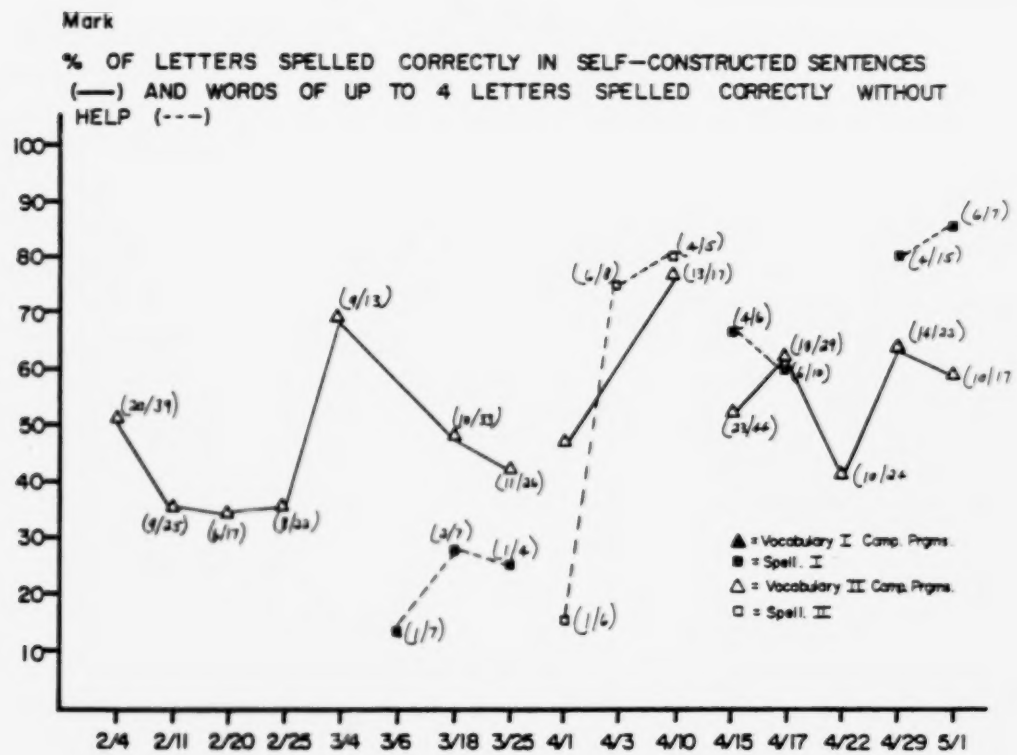
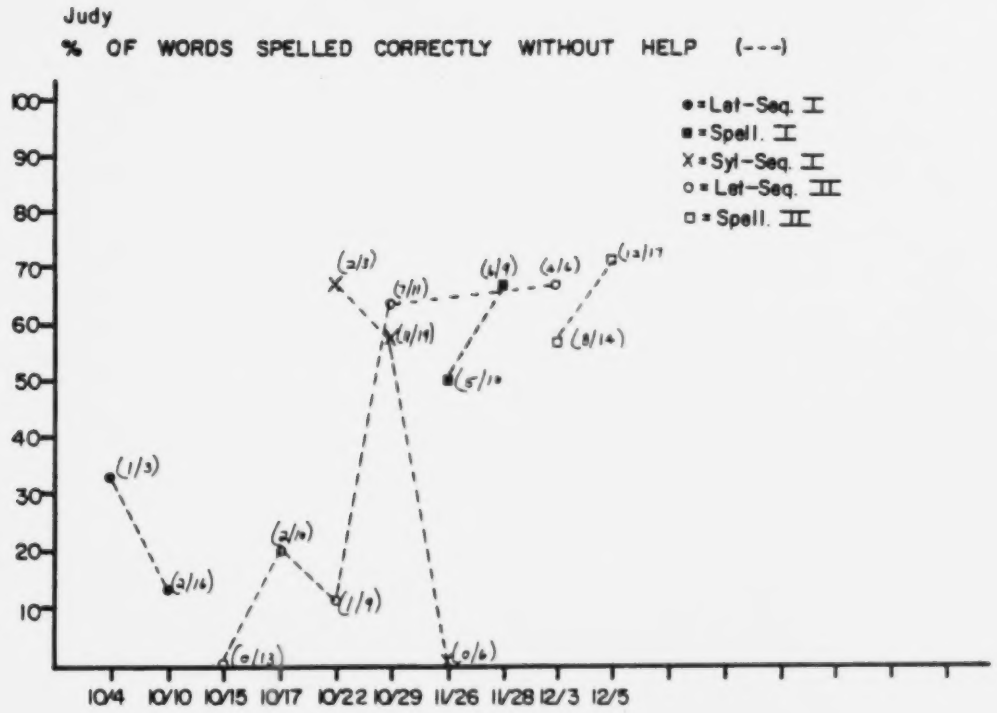


Figure 6. Mark's spelling progress in the first (above) and second (below) semesters. The number correct and the number of opportunities are in parentheses.



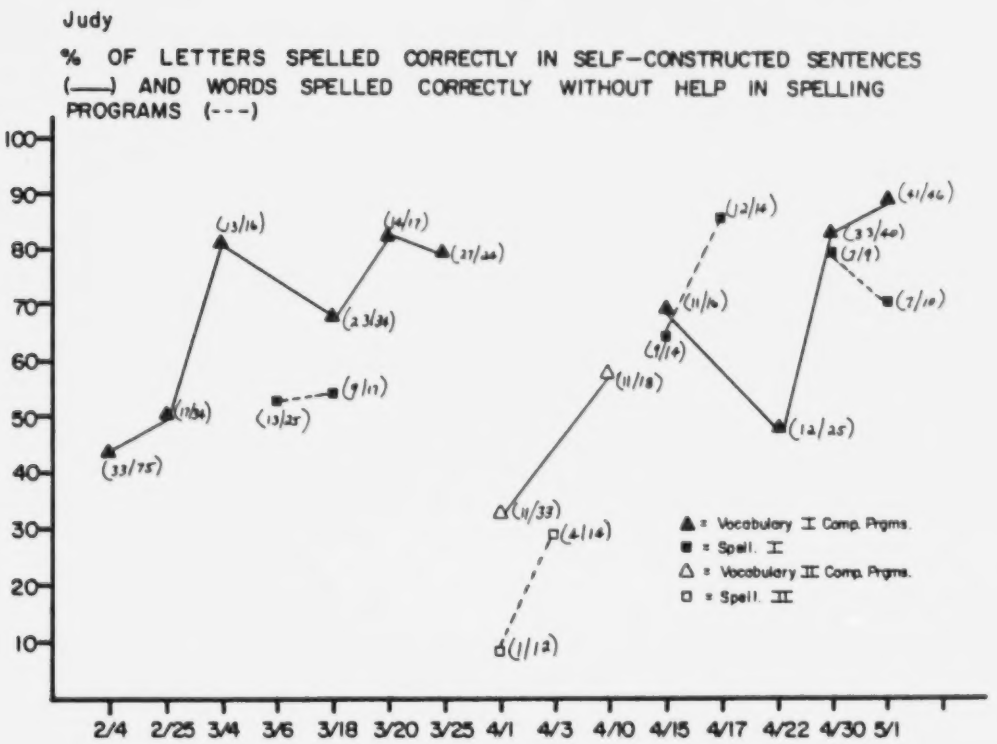


Figure 7. Judy's spelling progress in the first (above) and second (below) semesters. The number correct and the number of opportunities are in parentheses.